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Short communications and technical notes

An environmentally friendly alternative to single-use plastics for radiotherapy bladder preparation

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ABSTRACT

More than 60,000 plastic cups were used annually for bladder preparation in one radiotherapy centre. As an alternative, patients were provided with a specifically designed reusable water bottle, aiming to reduce waste and improve bladder filling compliance.

Cup usage and bladder volume at treatment were calculated pre- and post-implementation. Bladder volume was measured as a percentage of the planned volume and grouped for analysis.

Cup usage halved from 12,000 cups to 6000 cups. Percentage of bladder volumes in the optimal group increased from 47% to 54%.

The introduction of water bottles reduced plastic cup usage and increased bladder filling compliance.

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Introduction

Many patients receiving radiotherapy to the pelvis are required to have a comfortably full bladder for treatment each day [1–3]. This is achieved by following a bladder filling protocol which instructs patients to drink a pre-defined volume of water, often measured in plastic cups, and aims to standardise bladder volume over the course of treatment. Non-compliance with bladder filling instructions has implications for patients' side effects [4] and experience of radiotherapy treatment, whilst also impacting service provision when patients need to empty or re-fill their bladders causing delays.

At the Royal Marsden radiotherapy department, approximately, 1200 patients in the 2017/18 year were required to drink water in preparation for their radiotherapy. This resulted in more than 60,000 single-use plastic cups being used and immediately discarded as waste. Single-use plastic cups are known to be environmentally unfriendly due to their low recycling rate and slow degradation, which contributes to the huge amounts of plastic waste ending up in landfill or oceans worldwide [5].

An alternative solution was proposed to provide patients, at their pre-treatment appointment, with a reusable water bottle to measure and hold the required volumes of water. The patients would be advised to keep and bring the bottle for each session of

radiotherapy. By filling a reusable bottle to the required marker each day, patients would not need single-use plastic cups. The bottle would also serve as a reminder for patients to remain well hydrated over the course of treatment. By providing patients with an 850 ml reusable water bottle, radiographers could ask patients to aim to drink two of these over the course of the day; a simple instruction with a visual aid to help patients achieve the recommended daily fluid intake for cancer patients [6]. The bottle could then be kept for personal use or recycled in normal household recycling as it was made of polyethylene terephthalate 1 (PET1), an easily recycled substance that is commonly accepted in Local Council curb-side collections [7].

This paper describes the water bottle design and the impact on plastic cup usage and bladder preparation.

Methods

An application was made to the Royal Marsden Cancer Charity 'Innovation Den', an initiative which encourages members of staff to apply for monetary grants to fund forward-thinking projects, which was successful. Once funding had been secured, a water bottle was designed to best fit the aims of the project and acknowledge the funding of the charity (Fig. 1). The bottle was specifically designed with graduations to define the volumes required for radiotherapy bladder filling (e.g., 4 cups / 700 ml). These graduations aimed to help the patients measure the correct volume of water required for treatment and enabled preparation to be carried out at home, during transit or at the hospital.

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Fig. 1. Image of reusable water bottle with cup markings.

Instructions were printed on the bottles to indicate how the bottles should be cleaned, in this case hand wash only. Storage requirements and staff education to implement the water bottles into the patient pathway smoothly were also considered.

The bottles were introduced into the department in June 2020. Water bottles were provided to all patients who were required to fill their bladder for radiotherapy, including, but not limited to, patients having prostate, rectum or gynae treatment. Data was collected from the hospital procurement system to determine the number of cups ordered over two three-month periods, from January to March 2020 and July to September 2020, before and after implementation of the water bottles.

The impact on bladder volume was investigated by an audit of patients receiving radiotherapy to a pelvic site that required a full bladder for treatment. Bladder volume data was collected from the Mosaik record and verify system (Elekta AB, Stockholm, Sweden) where therapeutic radiographers record patients' bladder sizes as viewed on daily CBCT scans. Bladder size is recorded as a percentage of the planned bladder volume, for example 50% represents a bladder half the planning scan volume, 100% represents a bladder filled to the same volume as the patient's planning scan and 150% represents a bladder volume 50% larger than at the planning scan. Bladder sizes were grouped for analysis into the following categories: underfilled ($\leq 50\%$), small acceptable (51%–80%), optimal (81%–120%), large acceptable (121%–150%) and overfilled ($\geq 151\%$). Baseline bladder volume data was collected from 1st March 2020 to 31st March 2020, before the water bottles were implemented and then sampled again from 1st August 2020 to 31st August 2020 once the project had been established.

Results

From January to March 2020 the radiotherapy department ordered 12,000 cups. From July to September 2020, after implementation of the water bottles, the radiotherapy department ordered 6000 cups, halving the number of single-use plastic cups purchased.

Bladder volume data was recorded for 78% (n = 758) of patients during March and 88% (n = 579) of patients during August and the mean bladder volumes were similar for both periods (Table 1).

When analysed by group, the percentage of bladder volumes in the optimal range (81%–120%) increased from 47% to 54% between March 2020 (pre-implementation) and August 2020 (post-implementation) (Fig. 2). All other categories, which are considered

Table 1
Bladder volumes for March and August.

	March 2020	August 2020
Mean (SD)	95% (39.7)	93% (34.7)
Range	15%–400%	10%–300%

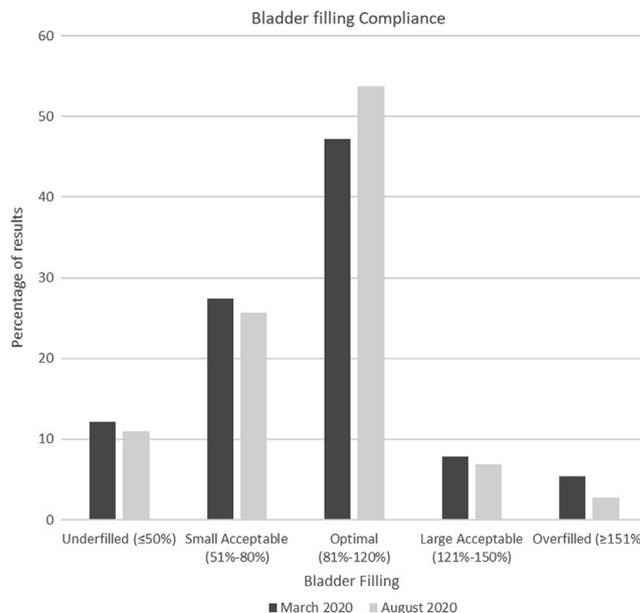


Fig. 2. Proportion of bladder volumes in pre-defined ranges, with 81%–120% deemed optimal volume.

less favourable showed a decrease between the same two time points.

Discussion

The implementation of reusable water bottles to the radiotherapy department has shown a marked reduction in the number of single-use plastic cups purchased. This suggests that the demand for single-use plastic cups has reduced and that patients are using the specifically designed bottles to measure water. Although the need for single-use receptacles remains for other patients, relatives and visitors to the department, it is hoped that as environmental awareness becomes more prevalent, further initiatives can be introduced and cup usage will decrease further. NHS England has a national ambition to reduce their environmental impact, via the “For a greener NHS” programme [8], working towards overarching worldwide sustainability strategies [9]. As part of this the NHS have a directive to reduce waste in hospitals and encourage greater reuse. Reducing the amount of single-use plastic cups in the department and exchanging these for a reusable and PET1 recyclable water bottle has contributed to this aim. There is further scope to exchange the remaining single-use plastic cups for a recyclable option, thus eliminating non-recyclable plastic cups in the department completely.

A barrier to introduction of bottles in other departments may be the additional costs associated with switching to reusable products. Reusable water bottles tend to cost more than single-use plastic cups, although savings may be made in other areas such as waste disposal. This project was funded by a charitable grant and future funding must be secured to ensure the ongoing provision of the water bottles.

While the mean bladder volumes decreased between March and August, an improvement in bladder filling can be seen when comparing the grouped data. The increase in the proportion of measurements recorded in the “optimal” group and decrease in all other (less favourable) groups clearly shows a benefit to patients, as treatments will have been delivered with an ideal sized bladder more frequently. Whilst other disciplines such as surgery [10] have highlighted to need to reduce the use of single-use plastics in clinical settings, to the authors knowledge, this is the only

published data on the use of reusable water bottles in radiotherapy.

Despite warmer average temperatures in August compared to March, which have been shown by an internal audit to reduce compliance with bladder filling, the data demonstrates increased compliance with bladder filling after the introduction of the water bottles. This suggests that patients maintained or even improved their levels of hydration at a time where it would be expected to reduce due to external factors.

Informal feedback from patients on the water bottle project has been positive overall, with one patient stating “I can easily monitor how much water I am drinking. It gives me the impetus to drink more water and the radiotherapy team are always pleased because I have a full bladder for my appointments. . .” Some negative feedback was received from a patient due to the cancer charity logo printed on the bottle, which is included in the design as an acknowledgement of the grant funding. This served as an unwanted reminder to the patient outside of their appointments that they were having cancer treatment. Staff have also given positive feedback on the water bottle project and have expanded on the idea by colouring in the correct cup marker on each patient's bottle in case they forget how much they were required to drink.

Conclusion

Reusable and recyclable water bottles reduce the amount of single-use plastic cups required for radiotherapy preparation, contributing to a positive environmental impact. Reusable water bottles are an effective way of assisting patients to fill their bladder to the required size for treatment, without the use of disposable cups. Furthermore, water bottles are a helpful aid for maintaining hydration levels throughout treatment, even in warmer months of summer.

Declaration of Competing Interest

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References

- [1] Fujioka C, Ishii K, Yamanaga T, Ogino R, Kishimoto S, Kawamorita R, Tada T, Nakajima T. Optimal bladder volume at treatment planning for prostate cancer patients receiving volumetric modulated arc therapy. *Pract Radiat Oncol*. 2016 Nov-Dec;6(6):395–401. DOI: 10.1016/j.prro.2016.05.007. Epub 2016 May 26. PMID: 27374192.
- [2] O'Doherty UM, McNair HA, Norman AR, Miles E, Hooper S, Davies M, et al. Variability of bladder filling in patients receiving radical radiotherapy to the prostate. *Radiother Oncol* 2006;79:335–40.
- [3] South CP, Khoo VS, Naismith O, Norman A, Dearnaley DP. A comparison of treatment planning techniques used in two randomised UK external beam radiotherapy trials for localised prostate cancer. *Clin Oncol* 2008;20:15–21.
- [4] Suneil Jain D, Loblaw A, Morton GC, Danjoux C, Szumacher E, Chu W, et al. The effect of radiation technique and bladder filling on the acute toxicity of pelvic radiotherapy for localized high risk prostate cancer. *Radiother Oncol* 2012;79(2006):335–40. <https://doi.org/10.1016/j.radonc.2012.09.020>.
- [5] National Geographic. (2017) A whopping 91% of plastic isn't recycled. Available at: <https://www.nationalgeographic.com/news/2017/07/plastic-produced-recycling-waste-ocean-trash-debris-environment/> (Accessed: 25.01.2021).
- [6] Cancer Research UK. (2020) Eating and drinking. Available at: <https://www.cancerresearchuk.org/about-cancer/cancer-in-general/treatment/radiotherapy/side-effects/general-radiotherapy/eating-drinking-during-radiotherapy#> (Accessed: 21.01.2021).
- [7] Sustainability Guide. (2018) What plastic can I recycle? Available at: <http://www.sustainabilityguide.co.uk/2018/02/05/recyclable-plastic/able> Plastic - What plastic can I recycle? - Sustainability Guide (Accessed: 25.01.2021)
- [8] NHS. (2020) For a greener NHS. Available at: <https://www.england.nhs.uk/greenernhs/> (Accessed 21.01.2021).
- [9] UN. (2015) Transforming our World: The 2030 Agenda for Sustainable Development. Available at: <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf> (Accessed 08.02.2021).
- [10] Chauhan MN & Majeed T. (2019) Use of plastic products in operation theatres in NHS and environmental drive to curb use of plastics. *World Journal of Surgery and Surgical Research*; 2:1088.